

Use of Multivariate function to identify chronic Diabetic Patients of Type1 from health database in Australia

Abstract. In recent years the use of technology has become very common and popular. By the use of technology we can easily accessed correct and useful information of a diabetic patient. However, finding such information of those patients who really need urgent medical treatment is limited and challenging. One method is to use technology that have strong mathematical functions, to extract the beneficial information about diabetic patients. Therefore, the integration of technology that have strong mathematical functions with health can identify serious diabetic patients from big health database of patients. This paper presents a mathematical function by which serous diabetic patients can be identified from health database.

Keywords. Multi Variate Function, Partial Derivative, Diabetics, Telehealth, Health database, Type 1(T1DM) and Type 2 (T2DM).

Introduction

The growing population of diabetic patients will continue to increase pressure on healthcare systems. Multidisciplinary research fields that integrate both Information and Communication Technologies (ICT) and healthcare disciplines are thus looking at advances to transform our personalized healthcare. Significant advances in the field of technology deliver cost-effective solutions to patient health management, anyone, anywhere, and anytime [1].

With rapid growth in technology, the development and management of patient's database is gaining more importance. This is to support doctors or medical practitioners to find chronic patient details from the big data of patients. Software developments have made the system to store such crucial data however to identify chronic patient details from billions of records is still a challenge. In this paper, we come up with new mathematical function by which we can identify chronic patient's details.

1. Literature Review

Diabetes Mellitus is a complex condition caused by either lack of production of Insulin in the beta cells of the Islets of Langerhans in the pancreas or the body cells fail to respond to the Insulin so that there is excess glucose in the blood. Glucose, is a 'simple' sugar, obtained from the enzymatic breakdown of starch and carbohydrates. It is an essential energy source required by the body cells to function. Since there is a lack of Insulin or insulin resistance, the cells begin to starve due to lack of glucose. Diabetes is often called 'starvation in plenty'. There is excess glucose in the blood circulation but not available to the cells to facilitate optimal function. Since the cells are not functioning at optimal capacity, critical tissue and organs are adversely affected. In the case of the eye, due to poor retinal blood vessel intercellular adhesion integrity there is

a tendency in poorly controlled Diabetes Mellitus, for retinal bleeding to occur. If left untreated this can lead to blindness. Similar haemorrhage in the brain and heart can lead to stroke (Cerebrovascular accident) and Myocardial Infarcts (Heart Attacks), respectively. In the case of the lower limb peripheries, this can lead to gangrene and foot amputations. It must be noted that there is no cell in the body that is immune to the adverse effects of Diabetes mellitus.

Diabetes mellitus has become quite prevalent at a global level. In Australia, 1.1 million people have been diagnosed with diabetes [8] and is prevalent in the Aboriginal and Torres Island population. There are two types of Diabetes Mellitus, Type 1(T1DM) and Type 2 (T2DM). Australian statistics have revealed that 120,000 people have suffered from Type 1 diabetes and 956,000 have Type 2 diabetes [9].

T1DM occurs when the body produces no insulin and is occasionally referred to as Juvenile Diabetes or Early-Onset Diabetes. It mostly occurs during teenage years or before the age of forty. Patients with T1DM need to take insulin injections for life and must ensure that their blood glucose levels stay balanced by eating a healthy diet, an effective exercise programme and carrying out regular monitoring of their blood glucose with blood tests. Whereas in T2DM, there is inadequate insulin and thus the cell does not work effectively.

In order to manage the blood glucose level, Diabetes patients need to maintain a balance between the quantity of food they eat, their physical activity and insulin medication. People with diabetes were placed on rigid diets and were given a list of dos and don'ts about eating. Some of the food restrictions were advised friends or family, which works sometimes but some of their advices may be out of date and inaccurate. It is difficult for Diabetes patients to find a food in the market which ensures that it not harmful for their health. As mentioned [5], poor diet and physical inactivity are the key factors in developing chronic diseases in humans.

For diabetes patients it is important to assess the consumption of sugar by establishing a link between the diet and disease. However, it is currently challenging as people have moved away from traditional homemade food to more Take-Away food and eating out. Consumption of such food makes it difficult for people to accurately assess their food intake and food composition. Advancement in ICT has brought essential health related information for Diabetes patients. Parallel to this growth, mobile devices provide different applications in the field of health that improves communication between health practitioners and patients [6]. It provides feedback on individual eating habits, which may enable people with diabetes to better manage their condition [7]. Previous research has developed tools that can support dietary management for Type 1 and Type 2 diabetes patients. Findings suggest that greater growth is required for mobile dietary and nutritional support in Diabetes patients. Mobile applications that support healthy eating habits should be integrated with applications for managing blood glucose and physical activity data, as well as medication data [5] [6].

However, mobile applications-based self-management is not a quick solution for the problem and it is critical to understand that its effect is based on strong behavioural change by the patient. Some patients encounter difficulties managing technical problems and others cannot afford the cost. Therefore, the adoption and use of user-centred and socio-technical design principles is highly needed to improve usability, perceived usefulness, and, ultimately, adoption of the technology [8].

There are many features that are discussed in [9] [10] [11] [12] [13] [14] but we only select those features which have importance and are still under research.

Following are the features that are extracted from the literature 2008 till now which includes: Real time, User Centred Sociotech Design, Functionalities, Augmented Reality, Usability, User, Estimate CHO, Measure meal composition, Independent Life Style and Clinically Accurate. We plotted all these features in the graph where X-axis is the time and Y-axis is the importance of these features. The plus sign indicates the importance and still under research.

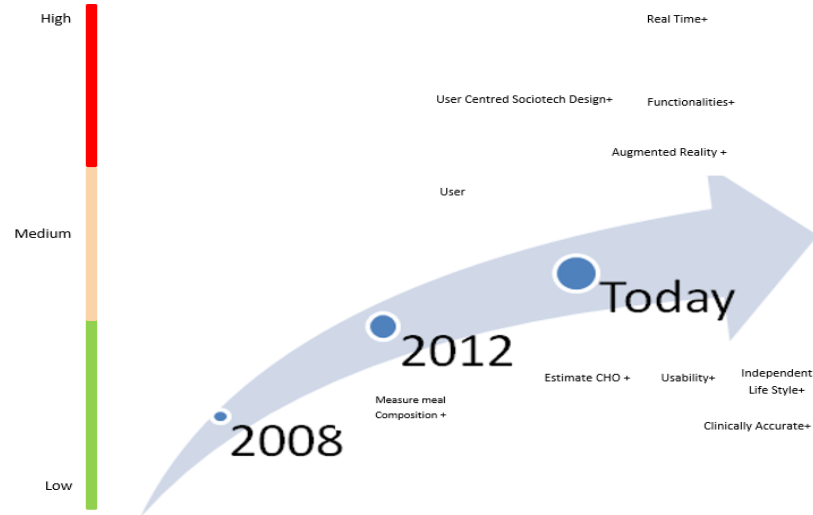


Figure 1. Time- Graph of most useful features

2. Use of Multivariate Function

To identify high sensitive “diabetes case” instantly we define a “Multivariate Function”.

The generalize form of a function is:

$y = f(x)$ and for ‘n’ variables it is expressed as

$$y = f(x_1, x_2, x_3, \dots, x_n)$$

These ‘n’ variables are ‘n’ number of patients.

To identify any particular patient, Partial Derivate of this polynomial is taken with respect to location of that patient. In other words if a chronic patient symbolize by x_6 i.e. out of a list of, for example, 100 patients we want to focus our attention to 6th patient.

$$\frac{\partial y}{\partial x_6} =$$

The medical condition of 6th patient (ignoring all other patients).

In this case if we know that this patient has been careless about his medicines, exercises or diet (in that order) then above equations becomes

$$\left. \frac{\partial y}{\partial x_6} \right|_{(medicine, exercise, diet)} = \text{the medical condition of 6th patient}$$

$$\text{or } \left. \frac{\partial y}{\partial x_6} \right|_{(m, e, d)} = \text{the medical condition of 6th patient}$$

This function is partially derived by substituting three values in form of order triple. In general we can use ordered pair, quadruple or n-tuples depending upon the number of carelessness attitude of the patient.

The gravity of seriousness of this patient is expressed as a function of combination of fractions like

$$y = \frac{1}{m^3} + \frac{1}{e^2} + \frac{1}{d^1}$$

For the purpose of solving by substituting values of three different variables m, e and d we take natural logarithm of this equation.

$$\ln y = \ln \frac{1}{m^3} + \ln \frac{1}{e^2} + \ln \frac{1}{d^1}$$

$$\ln y = \ln m^{-3} + \ln e^{-2} + \ln d^{-1}$$

$$\ln y = -3 \ln m - 2 \ln e - \ln d$$

The higher power in dominator indicates a very small value of fraction showing the acute condition of that patient with respect to its attribute.

For simplicity and convince we can divide our patient in some groups which at the end generate a numerical value indicating the seriousness of a patient.

Age Group (Years)	Number Value
Infant – 18	1
19 – 37	2
38 – 56	3
57 – 75	4

The database in our system calculates Total Number Value of Patient (TNVP) consisting of three characteristics which can be extended to any number as need arises.

TNVP = (Age Group Value) + (Weight Number) + (Consultation with Parents for age group 1 only)

Case 1:

For example our first patient is of 6years then its TNVP will be calculated as follows:

TNVP = (Age Group Value) + (Weight Number) + (Consultation with Parents for age group 1 only)

$$TNVP1 = (1) + (5) + (-1) = 5$$

The second term on the right hand side of this equation will start from that number will assume that number which will be after last value of age group.

The third term is -1 indicated highly careful parents of that patient as a result total value of TNVP will decreased and the patient will not be considered seriously compared to the following case.

$$TNVP2 = (1) + (5) + (+1) = 7$$

In this case the third term +1 indicates negligence of parent towards patient resulting in highest TNVP value.

In our system for any age group highest value shows a serious case which will reflected on the screen of database containing data of all patients.

Case 2:

$TNVP = (\text{Age Group Value}) + (\text{Weight Number}) + (\text{Behavior of the patient towards doctor advices})$

$$TNVP1 = (2) + (6) + (-2) = 6$$

In fact in all these values substitutions a sequel order of integers is being followed.

The first term on the right hand side of above equation shows group value.

The second term is regarding weight of the patient and is after value 5 of case 1.

The third term is for those patients who are very careful about their health and hence their TNVP cannot be maximum in their age group. Therefore these patients do not require immediate attention.

$$TNVP2 = (2) + (6) + (2) = 10$$

The similar description stands for this equation as that for TNVP1 expect third term showing casual attitude of the patient toward doctor advice.

As soon as a large number value appears on the screen we can immediately contact that patient for medical assistance.

3. Future Work

Based on the important factors as mentioned in section 2 and advanced mathematical function in section 3, we proposed an idea called BIG-GLUCON-HERO. This proposed idea is to use “multivariate function” in diabetic’s application along with sociotechnical design principles to identify chronic diabetic patients, support their independent lifestyle in order reduce the hospitalization. Further it can monitor patient food intake to control obesity, provide real time feedback from doctors and parents, support in decision making and interaction with outside world using social media and provide help in case of emergency.



Figure 2. BIG-GLUCON-HERO

4. Conclusion

The paper introduced a mathematical function called multivariate function and how this function can be beneficial in telehealth. Although the use of technology is getting more advanced in many fields especially health and medicine however having strong mathematical function inside the technology can be more helpful. This will help to extract useful information of diabetes patient from health database. In this paper, we reviewed the literature relating to using technology to help diabetes patient in selecting nutritious food and avoid obesity. From the literature it seems that some features as mentioned in section 2 are still under research, despite the fact there is rapid growth in technology but identification of chronic patients (based on special parameter like medicine, exercise and diet) are still challenging. Whereas usability, real time support, clinically accuracy and interface design are still major concerns in health applications. Finally Big-Glucon-Hero is a proposed idea that uses “multivariate function” in diabetic application along with sociotechnical design principles to identify chronic diabetic patients, support their independent lifestyle in order reduce the hospitalization.

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